BRADY CANAL HYDROLOGIC RESTORATION PROJECT (TE-28)

I. INTRODUCTION

I.1. Project Description

The Brady Canal Hydrologic Restoration Project is located within the Bayou Penchant-Lake Penchant watershed and was authorized for federal and state funding on the third (3^{rd}) Priority Project List (PPL) of the Coastal Wetlands Planning, Protection, and Restoration Act of 28 November 1990 (CWPPRA). The 7,653-acre (3097-hectares) project is bounded by Bayou Penchant, Brady Canal, and Little Carencro Bayou to the north, Bayou de Cade and Turtle Bayou to the south, Superior Canal to the east, and Little Carencro Bayou and Voss Canal to the west. The Mauvais Bois Ridge bisects the area and provides for a hydrologic differentiation between the northern and southern sections of the project area. The approximate center of the project area is Latitude 29°52'30" North and Longitude 91°29'30" West (USDA-NRCS 1996).

The project features when the project was proposed for CWPPRA funding included (USDA-SCS 1993):

- Four (4) one-way flapgated structures
- Modification of 9,650 feet (2941 m) of bank to allow overbank flow into the Project area
- Four (4) rock weirs
- Armor three (3) existing outlets with rock
- Maintenance of 21,513 feet (6557 m) of existing embankments

The project components as listed in the Project Plan/Environmental Assessment consisted of constructing (USDA-NRCS 1996):

- Bulkhead with boat bay & two flapgated variable crest sections (1)
- Fixed crest weir with barge bay (1)
- Fixed crest weir with variable crest sections (3) [replace existing structures]
- Fixed crest weir (1) [replace existing structure]
- Rock Plug (1) (315 ft/96 m)
- Stabilize channel cross-section w/ rock (2)
- Earthen embankment (15,000 ft/ 4572 m)
- Maintenance of existing overflow bank (21,600 ft/6584 m)
- Maintenance of shore & earthen embankment
- Maintenance of existing structures

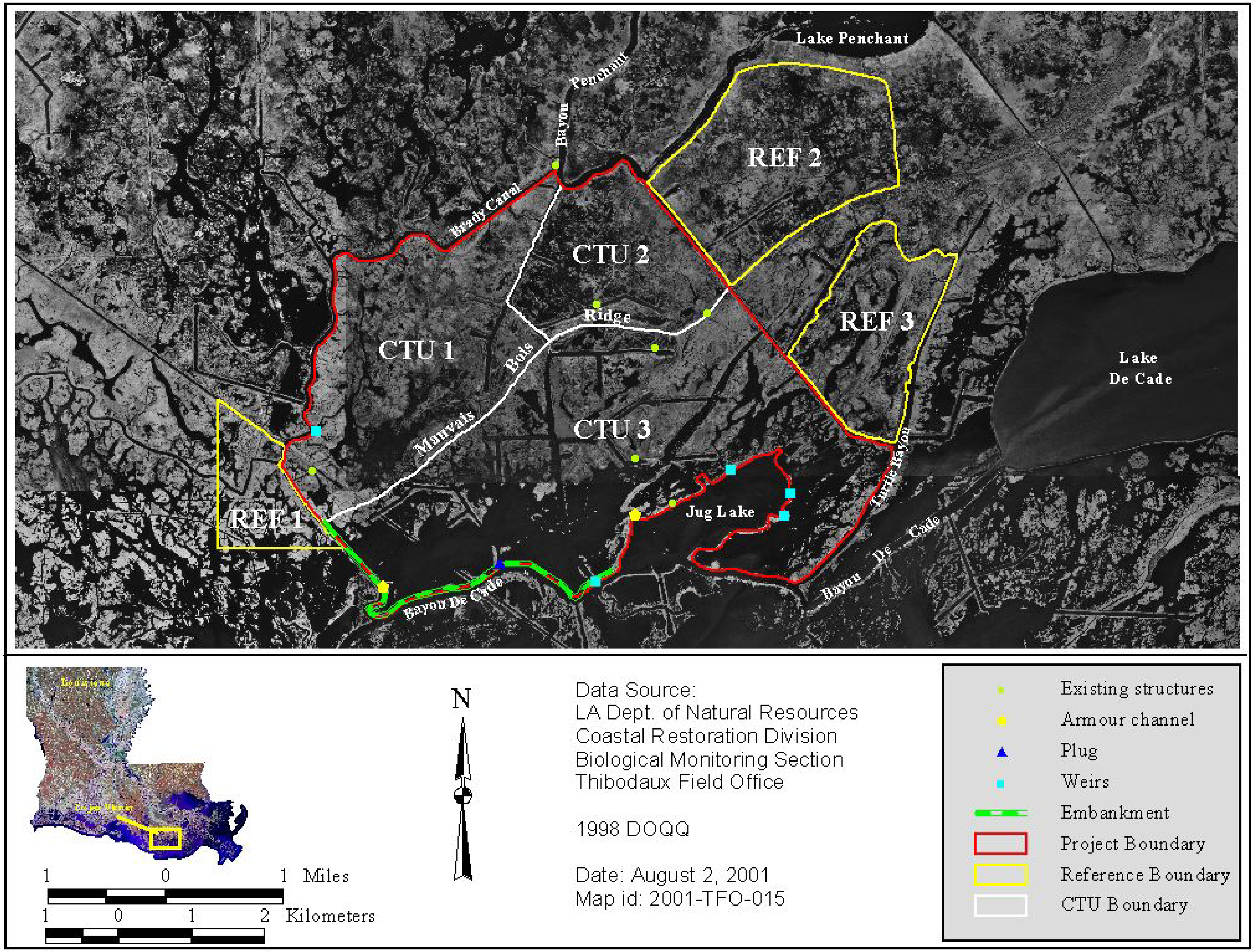

Figure 1. Location and project features.

The as-built features of the project when construction was completed on July 10, 2000 included (USDA-NRCS 2002):

- Four (4) steel sheet pile weirs with variable crest bays
- One (1) composite steel sheet pile and rock riprap weir with a barge bay
- One (1) rock riprap plug
- Two (2) rock armored channel crossings
- Constructed 8,531 feet (2600 m) of earthen embankment
- Constructed 4,405 feet (1343 m) of rock riprap armored earthen embankment
- Installed 3,660 feet (1116 m) of rock riprap embankment
- Maintenance of 21,600 feet (6584 m) of earthen embankments (no construction).

I.2. Project Personnel

Project Phase	Name	Position	Agency
Planning	Kevin Roy	Biologist	NRCS
	Gerry Bodin	Biologist	NRCS
	Faye Talbot	Project Manager	NRCS
	Gary Eldridge	Project Engineer	NRCS
	Clark Allen	Project Manager	LDNR/CRD
Implementation	Faye Talbot	Project Manager	NRCS
	Cherie LaFleur	Design Engineer	NRCS
	Clark Allen	Project Manager	LDNR/CRD
	Dale Garber	Const. Engineer	NRCS
	Melvin Rodrigue	Const. Inspector	NRCS
Monitoring	Todd Folse	Monitoring Manager	LDNR/CRD
	Marty Floyd	Biologist	NRCS
	Richard Abshire	Project Manager	NRCS

II. PLANNING

II.1. Causes of Loss

What was assumed to be the major cause of land loss in the projected area?
Natural and human-induced hydrologic changes that contributed to the loss of emergent wetlands within the project area included (USDA-NRCS 1996):

1. increase in water levels as a result of relative subsidence
2. increase of inundation related to the prograding delta system to the west
3. increase of tidal water exchange due to:
    a. oil and gas canals
    b. loss of natural bayou banks
    c. loss of wetlands seaward of the project area

This area has a loss rate of 31 acres (13 ha) per year. Natural processes causing erosion (e.g. subsidence, saltwater intrusion, tidal scour) were responsible for 77 percent (1,406 ac./569 ha.) of the total land loss within the project area. Penland et. al (1992) documented the sea-level rise to be 0.51 inches/year (1.30 cm/yr) and the rate of subsidence in the Terrebonne Delta complex to be 0.46 inches/year (1.17 cm/yr). This is the highest rate of subsidence in coastal Louisiana.

What were assumed to be the additional causes of land loss in the projected area? The natural levee ridge of Bayou Decade has eroded along its southern boundary. This had created a direct connection between higher salinities from the south and an increased affect from storm surges and tidal scouring. Also in 1992 Hurricane Andrew had a devastating affect on the marshes in the southwest area of the project where Bayou Decade and Voss Canal meet (Young 1998).

In addition, indirect impacts (i.e. human induced land-loss) caused directly by human activities include impoundment of wetlands by canal spoil banks and widening of canal banks as a result of recreational and commercial boat traffic (USDA-NRCS 1996).

II.2. Background

Frontal passages are readily apparent in the winter. The dewatering effects of particularly strong fronts seem to take about 1 week to pass and allow the marshes to refill. This will almost certainly change if the hydrologic restoration efforts are successful. It seems likely that hydrologic restoration components will take some of the weather-related set up peaks off of the spring time high water periods due to slower water movement into the marshes. However, the set up should still be sufficient to essentially stop or even reverse the sediment-laden river flows from the Atchafalaya-GIWW (Foote Undated).

The natural levee ridge of Bayou DeCade has eroded to below marsh level over several thousand feet along the southern project boundary. This has provided a direct hydrological connection to higher salinity waters from the south and protection from storm surges and tidal scouring has been lost. Deterioration of this ridge has exposed fresh/intermediate areas to the increased salinities and tidal exchange of the more brackish marshes to the south. Oilfield canals from Bayou DeCade have also increased tidal exchange and provided direct routes for saltwater intrusion. Because of their high organic content, marshes in the project area and those to the north are not able to withstand the tidal energies and rapid water exchange rates. Exposing these areas to unnatural hydrologic events could result in rapid conversion of emergent marsh to open water.

During the planning phase of the project, low spoil embankment areas were identified in the southern portion of the project along Superior Canal, Bayou Decade, and Turtle Bayou. Approximately 21,600 feet (6584 m) of spoilbank maintenance was planned, as needed during the 20 year life of the project, to address the possibility of breaches forming and rendering adjacent water control structures useless.

II.3. Project Goals and Objectives

How were the goals and objectives for the project determined?
The original goals and objectives for the project were developed in the late 1980's and targeted water management to reduce rapid water level changes and prevent the incursion of saline waters into the area. They were developed based on landowner knowledge of the property and mapping conducted in the late 1970's that showed a movement of brackish marsh northward in central Terrebonne Parish – characterized as a 'retreat' of the fresh marsh zone in Penland et al. (1988). The goals and objectives stated in the 1996 Final Plan and Environmental Assessment include freshwater and sediment retention as important objectives in addition to reducing the exchange rate of tidal waters (USDA-NRCS 1996). This reflects an increasing understanding in the late 1980's of the importance of both freshwater and sediment introduction into degraded brackish marshes.

Are the goals and objectives clearly stated and unambiguous?
While the goals indicate the desired trends in wetland loss and vegetative cover, no quantitative measures are stated. The way in which freshwater introduction and sediment retention will be achieved is described but no specific salinities or sedimentation rates are provided. For some areas this may too vague a basis on which to proceed with project design, however this part of the Terrebonne marshes has undergone substantial hydrologic changes in the last decade and such qualitative targets maybe more appropriate. In particular, changes in navigation channel configuration in the Bayou Chene/Bayou Black area in the early 1980's allowed a greater flow of Atchafalaya waters to the east. The movement of these waters into the marshes is complex, depending on river stage, wind and tide conditions. It is likely to occur through larger established channels such as Bayou Penchant (either directly from Bayou Chene or via other channels such as Bayou Copesaw) or Blue Hammock Bayou. The project's objective is to make use of these resources in the project area. The complexities of the water and sediment movements, both then and now, make specific quantitative targets for this aspect of project performance unrealistic.

Are the goals and objectives attainable?
Hydrologic restoration is currently considered the best and most feasible alternative to meet the objectives of landowners, federal and state government mandates, and to maintain existing marshes and increase marsh productivity in the project area. Accomplishing this through enhanced utilization of currently available freshwater and sediments and reducing tidal exchange is consistent with the goals, objectives, and strategies expressed by the Louisiana CWPPRA Task Force with regard to this portion of the Mississippi River Deltaic Plain.

The goals and objectives as stated in 1996 project documentation were achievable with the project design proposed at that time. By 1996 there was increasing recognition of the extent of influence of Atchafalaya freshwater and suspended sediments into the marshes of western and central Terrebonne Parish. The project was designed to take advantage of these resources. The timely remediation of post-construction problems (i.e. embankment breaches, operation of structures) is critical towards the achievement of the goals and objectives of the project.

Do the goals and objectives reflect the causes of land loss in the project area?
The goals and objectives reflect the changing understanding of land loss throughout the development of the project and the changes which occurred in the landscape during the planning period. The project area was severely impacted by Hurricane Andrew in 1992 when sustained winds of 43 m/s were measured at the site and a rapid water level rise of 1.5m (Dingler et al., 1995). Salinities reached 15 ppt (Jackson et al., 1995). The physical stresses caused great damage to the marsh substrate and severely fragmented the banks of Bayou DeCade and other channels on the south side of the project (hence the 1996 objective of restoring the channel banks).

The hydrologic restoration alternative was selected as the preferred plan. The project has been developed to combat wetland loss in the area and to enhance existing conditions. Project objectives will be accomplished using structural means to reduce water velocities and enhance utilization of freshwater and sediments that are being introduced into the project area. The major goal of the project is to reduce adverse tidal effects on the project area, as well as to better utilize available freshwater and sediment for maintenance of the project area marshes. The project is expected to reduce wetland loss rates, increase emergent marsh vegetation, and improve fish and wildlife habitat on 7,653 acres (3097 ha) of fresh, intermediate, and brackish marsh and shallow open water bodies. The project goals will be accomplished through management of hydrologic parameters.

III. ENGINEERING

III.1. Design Feature(s)

What construction features were used to address the major cause of land loss in the project area?
Four steel sheet pile weirs with variable crest bays, one composite steel sheet pile and rock riprap weir with a barge bay, one rock plug, two rock armored channel sections, 8,531 feet (2,600 m) of earthen embankment, 4,405 feet (1,343 m) of rock riprap armored earthen embankment, and 3,660 feet (1,116 m) of rock riprap embankment were constructed in this project (USDA-NRCS 2002). A final

inspection, marking the completion of construction was conducted on July 10, 2000.

The Brady Canal Project was one of the first coastal restoration projects in south Louisiana to plan the construction and maintenance of “overflow banks”. The intention of such banks is to allow water from adjacent water courses to overtop embankments during high tides without breaching. This allows freshwater and sediment resources to enter and benefit interior marshes that are otherwise segregated from such resources. It also allows water management capabilities via water control structures during lower tide levels. Breaching is hindered by the use of low profile, wide base embankments.

Although not a part of construction, the project included maintenance of 21,600 feet (6,584 m) of existing spoil embankments. At some time prior to construction (date unknown), breaches of the spoilbank along the north side of Bayou Decade and west side of Turtle Bayou began to occur. Such breaches would have a negative impact on the functional capabilities of water control structures no. 23 and 24. Also, the existing weir at the mouth of Brady Canal and Bayou Penchant was planned for enlargement so as to increase freshwater flow within the project area. Restoration of the same areas of low spoilbank and the Brady Canal weir were also identified in the TE-34 Penchant Basin Natural Resources Plan Project, authorized on CWPPRA’s Sixth Priority Project List (PPL). Due to limited available funding budgeted for construction in the Brady Canal Project, sponsoring agencies decided that such breaches and the Brady Canal weir would be deferred to the TE-34 Project.

What construction features were used to address the additional causes of land loss in the project area?
N/A

What kind of data was gathered to engineer the features?
On site investigations, preliminary design surveys, design surveys, and a geotechnical investigation.

What engineering targets were the features trying to achieve?
Maintain existing marshes by enhancing freshwater introduction and sediment retention within a highly fragmented transitional marsh along the western edge of the Mauvais Bois Ridge. Promote freshwater flow from Bayou Penchant into the marshes. Decrease tidal water exchange rates by reducing the channel cross-section of human made and eroded natural channels. Channel banks were to be restored and maintained to enhance sediment retention and prevent expansion of tidal channels into interior ponds.

III.2. Implementation of Design Feature(s)

Were construction features built as designed? If not, which features were altered and why?

A large amount of earthen embankment was changed to rock armored earthen embankment. This was due to the significant under-run of rock quantities used in the construction of the rock dike portions of the contract. It was decided to utilize the quantity of rock originally in the contract and armor as much of the earthen embankment as possible.

III.3. Operation and Maintenance

Were structures operated as planned? If not, why not?

For the first eleven (11) months following the completion of the project, there was no operational plan developed to operated the variable crest weir structures at Brady Canal, therefore, no operations were performed. The reason the three variable crest weir structures were not operated is that the U.S. Corps of Engineers permit for the project did not indicate that these structures were to be actively managed and operated and no operation schedule was outlined in the permit. However, on August 22, 2001, a meeting was held at Castex Laterre's office in Houma to discuss the possible benefits of operating these structures and to develop an operation schedule which would contribute to the goals of the project. The attendees included representatives from Castex Laterre, Burlington Resources, NRCS, DNR, and Puburn and Odom. During the meeting, DNR representatives presented a plan to operate these three (3) structures based on monitoring data gathered for the project. The proposed operation schedule requires that during the fall (September 1) of each year, the stop logs of all structures be placed at the maximum elevation, and during the spring (March 15) of each year, lower and remove stop logs to the natural channel bottom. All parties present for the meeting were agreeable to this proposed plan of operation. This operation schedule has been incorporated into the final version of the Operation and Maintenance Plan and as of September 2001, all structures have been in compliance with the operation schedule mentioned above. On April 1, 2002, DNR tasked Pyburn and Odom to perform spring operations of removing stop logs from all three (3) structures.

Are the structures still functioning as designed? If not, why not?

It is DNR's opinion that the only structure functioning as designed would be the variable crested weir located near the camp "Better Livin" along Carencro Bayou (NRCS site#14). Consequently, the structures located along the east side of Jug Lake are not functioning as designed. Regardless of the position of stop logs in these structures, they are not serving their purpose due to large openings and breaches in the levee system along Bayou Decade from Jug Lake to Turtle Bayou. Without this bank line, water is able to move freely between the marsh area and Bayou Decade. Pyburn and Odom, MCA, has been tasked and completed the final plans and specifications to repair these breaches. Estimated construction date for this maintenance project is October 2002. Once the bank line along Bayou Decade is re-established, it is anticipated that the structures along the east side of Jug Lake will function more effectively.

Was maintenance performed?
According to Field Trip Reports, the engineering section of the DNR Thibodaux Field Office has made three inspections.

May 17, 2001: Visit and evaluate various water control structures in the project area and document known levee breaches bordering the site.

June 19, 2001: Visit and assess existing structures and levees for possible damage from Tropical Storm Allison.

August 18, 2001: Inspection of structures and embankments in the Brady Canal Hydrologic Project area.

From the inspection trips, it was determined that maintenance to the water control structures was not needed. However, from the annual inspection on August 18, 2001, it was determined that maintenance of existing levee embankments including the repair of large breaches along Bayou Decade would be required. As mentioned above, Pyburn and Odom, MCA, have submitted final plans and specifications for the maintenance project.

IV. PHYSICAL RESPONSE

IV.1. Project Goals

Do monitoring goals and objectives match the project goals and objectives?
The objectives stated in the monitoring plan dated May 29, 1996 (revised July 23, 1998) are (1) Maintain and enhance marshes in the project area by reducing the rate of tidal exchange and (2) Improve the retention of introduced freshwater and sediment. The goals in the plan are (1) Decrease the rate of marsh loss (2) Maintain or increase the abundance of plant species typical of a freshwater and intermediate marsh (3) Decrease variability in water level within the project area (4) Decrease variability in salinities in the southern portion of the project (5) Increase vertical accretion within the project area and (6) Increase the frequency of occurrence of SAV within the project area (Young 1998).

The monitoring goals and objectives, as established above, encompass the intent of the project stated in the project plan and environmental assessment (EA) dated February 1996 (USDA-NRCS 1996). The EA states "the proposed project is to be implemented in order to maintain existing marshes in the project area. Marshes will be maintained by enhancing freshwater introduction and sediment retention within a highly fragmented transitional marsh along the western edge of the Mauvais Bois Ridge. Reducing the channel cross-section of human-made and eroded natural channels will decrease tidal water exchange rates. Channel banks will be restored to enhance sediment retention and prevent expansion of tidal channels into interior ponds."

The goals and objectives in the monitoring plan are consistent with the project features and the project plan and environmental assessment.

Figures 2 and 3 represent the location of DNR's Continuous Recorder and Vegetation Stations.

IV.2.1. Elevation

What is the range of elevations that support healthy marshes in the different marsh types?
Sasser (1994) classifies the project area as a floating thin-mat, herbaceous vegetation (northern section of CTU 2) and a floating thick-mat, herbaceous vegetation (part of CTU 2 and all of REF 2) marsh. Hourly data loggers were established in 1998 to monitor the vertical movement of the marsh surface. In the floating thin-mat marsh, the vertical range of the marsh surface was greatest in 2001 with a variability of 2.35 ft. (0.72 m) with a minimum reading of 0.45 ft. (0.14 m) and a maximum of 2.80 ft. (0.85 m). The floating thick-mat marsh had a vertical range of 0.70 ft. (0.21 m) with a minimum reading of 0.99 ft. (0.30 m) in 2001 and maximum reading of 1.69 ft. (0.52 m) in 1998. The minimum and maximum elevations have been converted to the North American Vertical Datum of 1988 (NAVD 88). Monitoring efforts relative to measuring marsh surface elevation variances do not occur in other areas of the project or reference areas.

Does the project elevation fall within the range for its marsh type?
Due to the floating nature of these marshes, an assessment with respect to elevation can not be stated since other publications have not tied their work to the same datum.

Did the project meet its target elevation?
The project was not built to meet a target elevation since dredge material was not pumped. This question is not applicable to this project.

What is the subsidence rate and how long will the project remain in the correct elevation range?
The subsidence rate in this area is 0.51 inches (1.29 cm) per year (subsidence and sea level rise). The subsidence rate is 0.46 inches (1.17 cm) per year and sea level rise is 0.05 inches (0.12 cm) per year (Penland et al. 1989). These rates are the highest in coastal Louisiana.

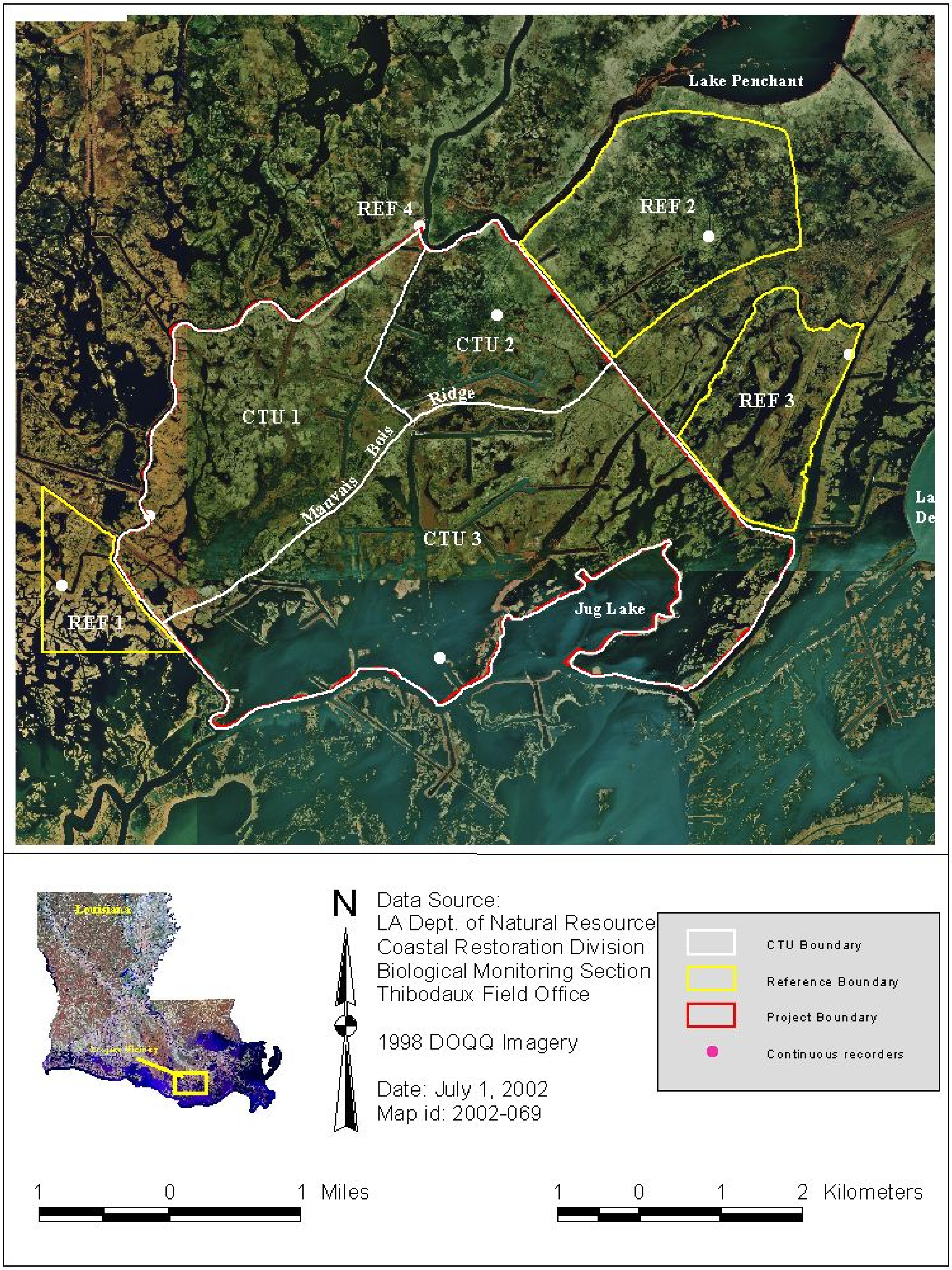

Figure 2. Location of continuous recorders.

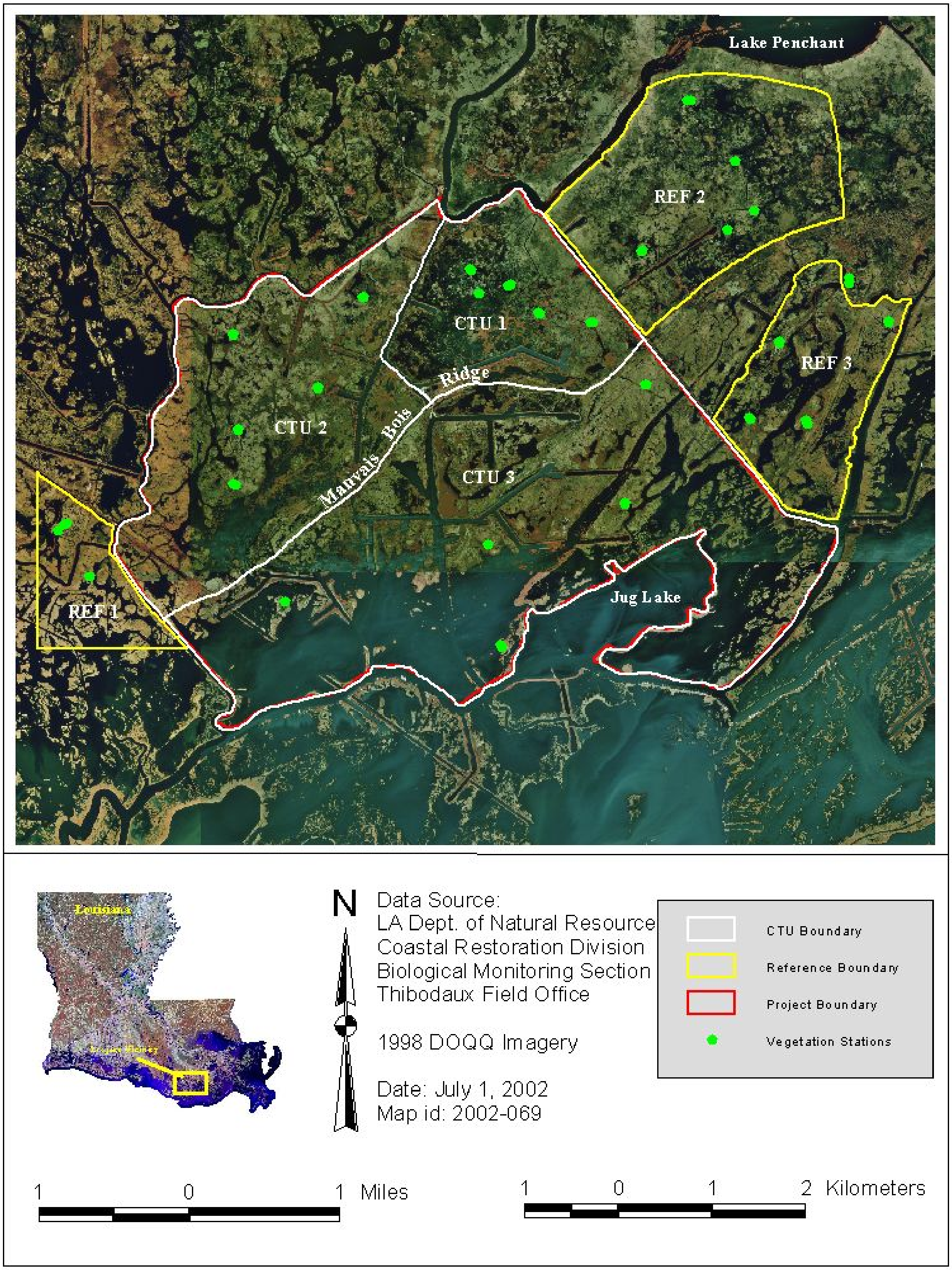

Figure 3. Location of vegetation stations.

IV.2.2. Hydrology

What is the hydrology that supports healthy marshes in the different marsh types?
Since this project and associated reference areas are unique, few studies have indicated the appropriate hydrology that supports healthy marsh vegetation. Figures 4a-d represent the depth and duration of flooding in CTU 2 and REF 2 from 1998 to2001.

Does the project have the correct hydrology for its marsh type?
As mentioned in the previous answer, this is a unique system that has few publications dealing with the hydrology with respect to healthy marshes. By examining Figures 4a-d, a visual representation is presented on how the marshes respond to the vertical movement of the surrounding water levels.
What were the hydrology targets for the project and were they met?
Goal 3 of the monitoring plan is to "Decrease variability in water level within the project area." The project was not built to meet specific water elevations. Data analysis of the water level variability by year for pre- and post-construction showed a significant difference between each CTU and the associated REF area. Water level variability was calculated by taking the hourly water level readings and subtracting the hourly reading from the previous reading. T-tests were then performed to compare the project to the reference area. Figures 5 and 6 show the mean water level and maximum water level.

To answer the question, "has the water level variability decreased," is still under investigation. In 2000 south Louisiana experienced a drought year, and in June 2001, south Louisiana experienced a tropical storm that produced 30+ inches of rain.

IV.2.3. Salinity

What is the salinity regime that supports healthy marshes in the different marsh types?
Brady Canal Hydrologic Restoration Project is divided into three conservation treatment units (CTU) and three reference units. To understand the salinity regime within all three units and their associated reference areas, the figures 7-10 show the mean and maximum salinity regimes from April through September (growing season) of each year from 1997 through 2001.

Two data results that need to be addressed are (1) in 1998, the salinity probe on the data logger in CTU 2 was in the mud; therefore, no readings were analyzed and (2) in 1997, the data recorder in REF 3 was not recording during the high salinity period.

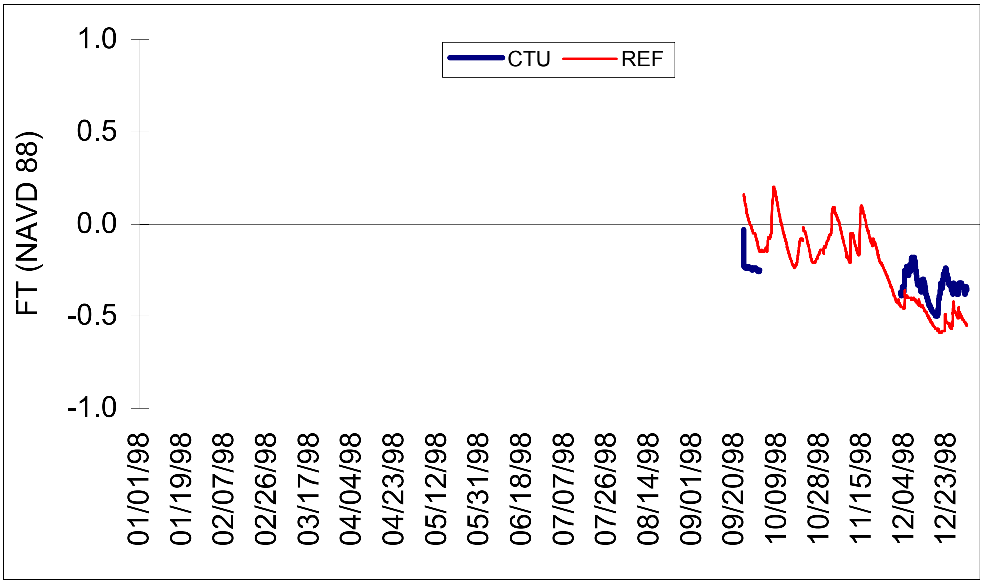

Figure 4a. Depth and duration of flooding in 1998.

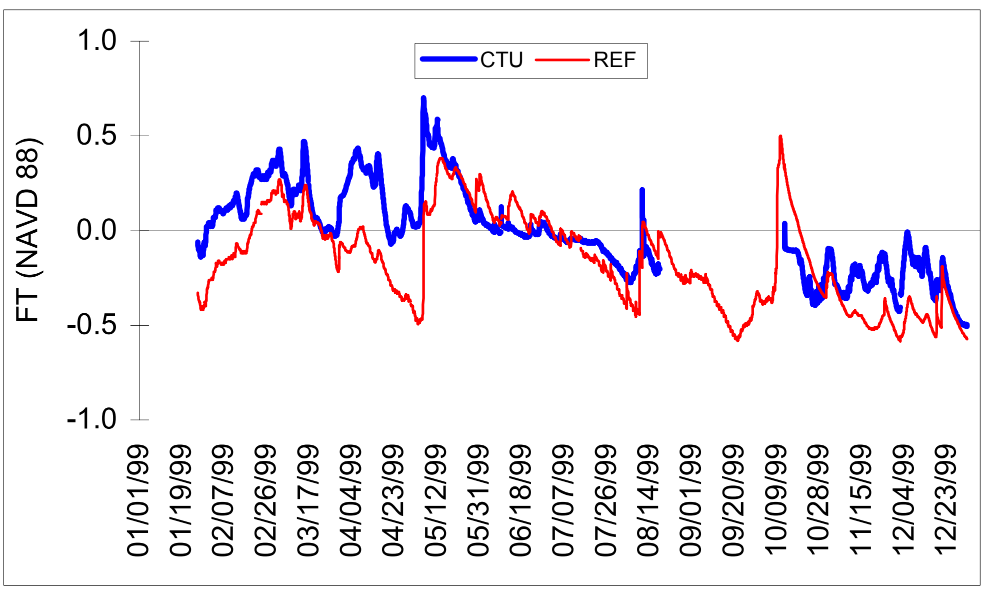

Figure 4b. Depth and duration of flooding in 1999.

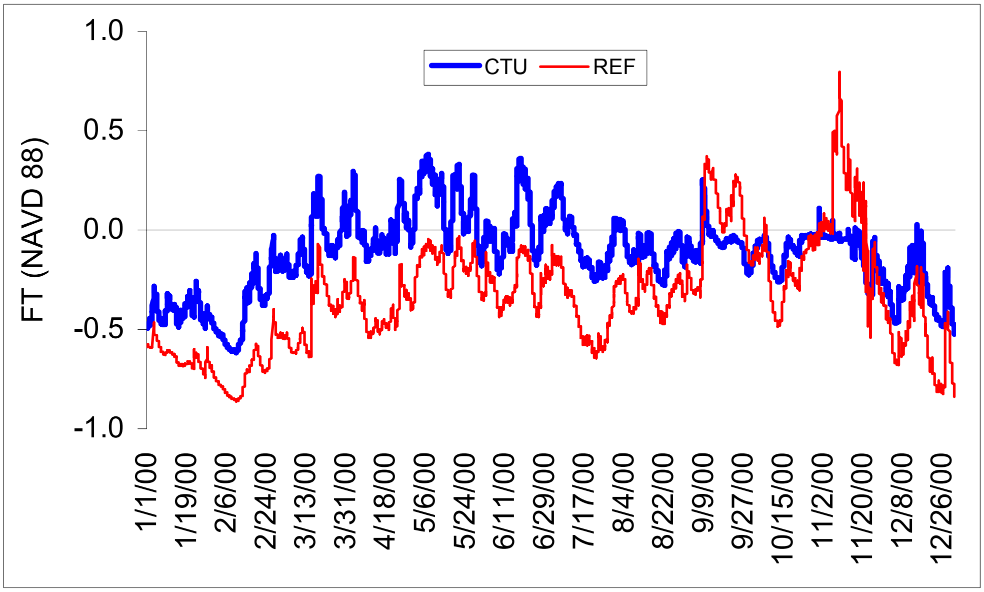

Figure 4c. Depth and duration of flooding in 2000.

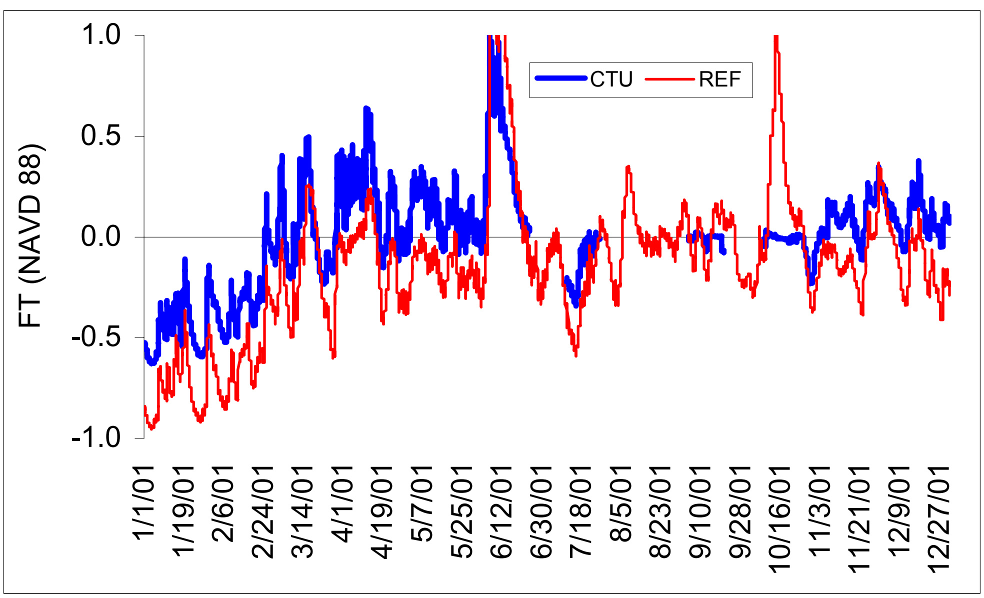

Figure 4d. Depth and duration of flooding in 2001.

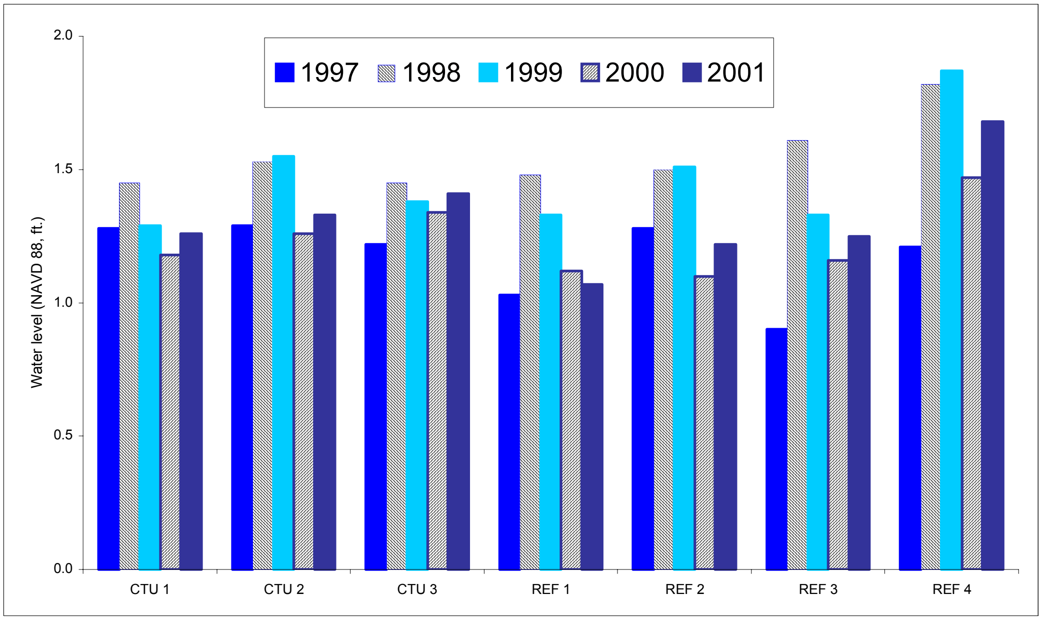

Figure 5. Mean water level comparison between each area by years.

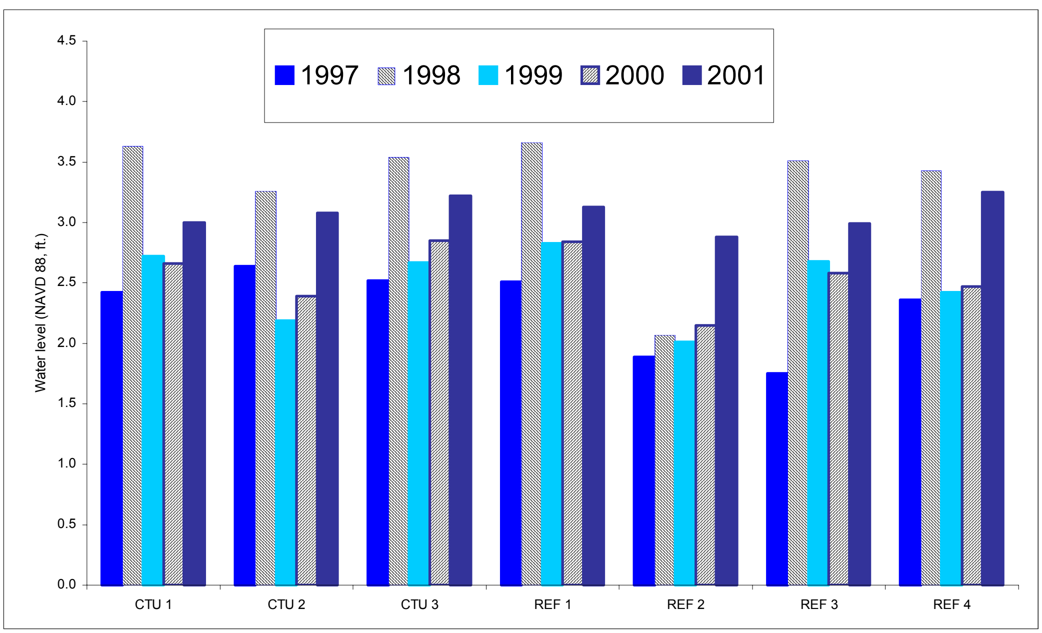

Figure6. Maximum water level comparison between each area by years.

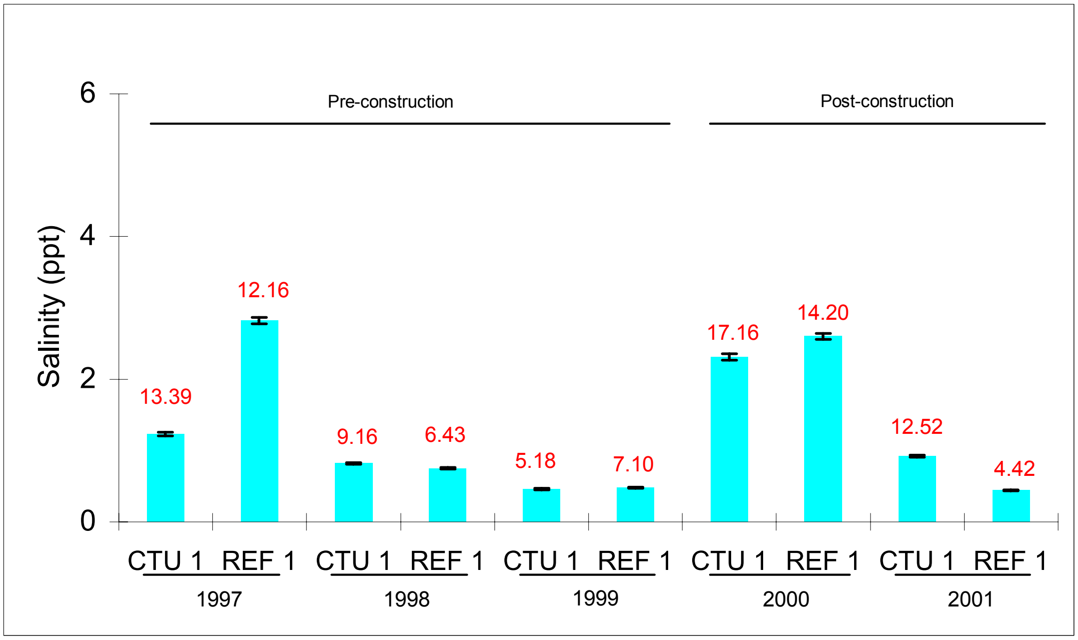

Figure 7. Mean and maximum salinity for CTU and REF 1.

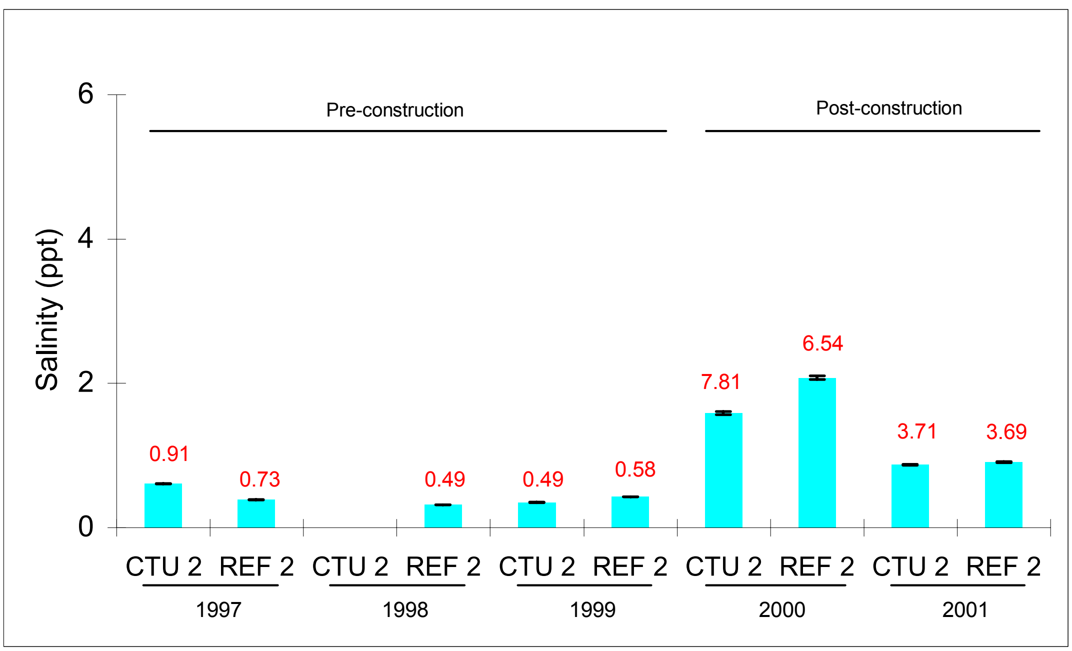

Figure 8. Mean and maximum salinity for CTU and REF 2.

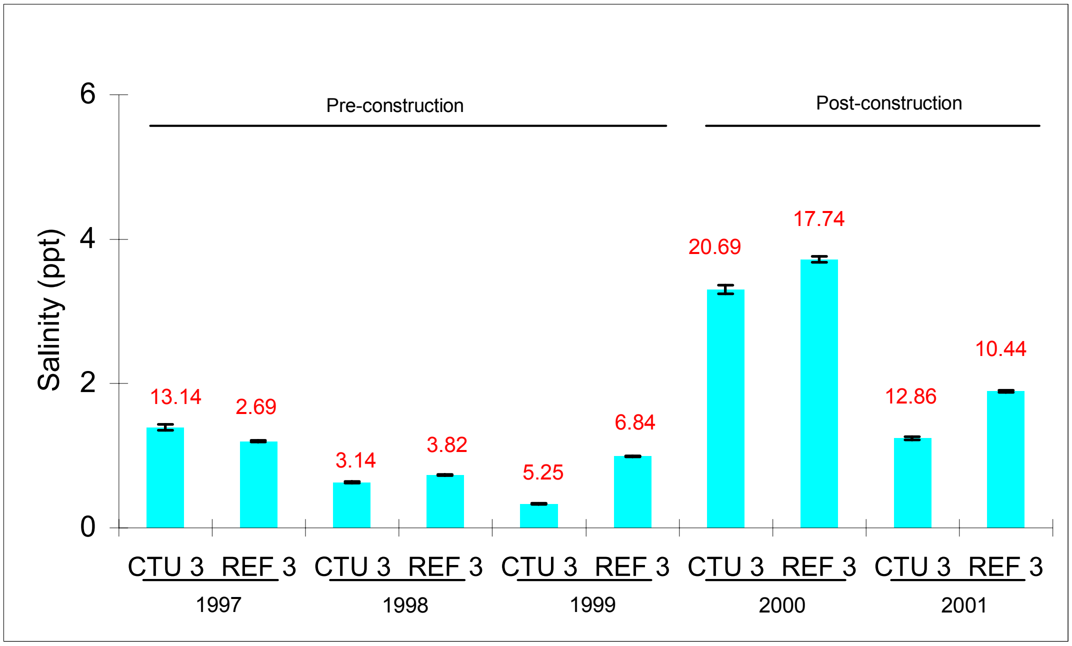

Figure 9. Mean and maximum salinity for CTU and REF 3.

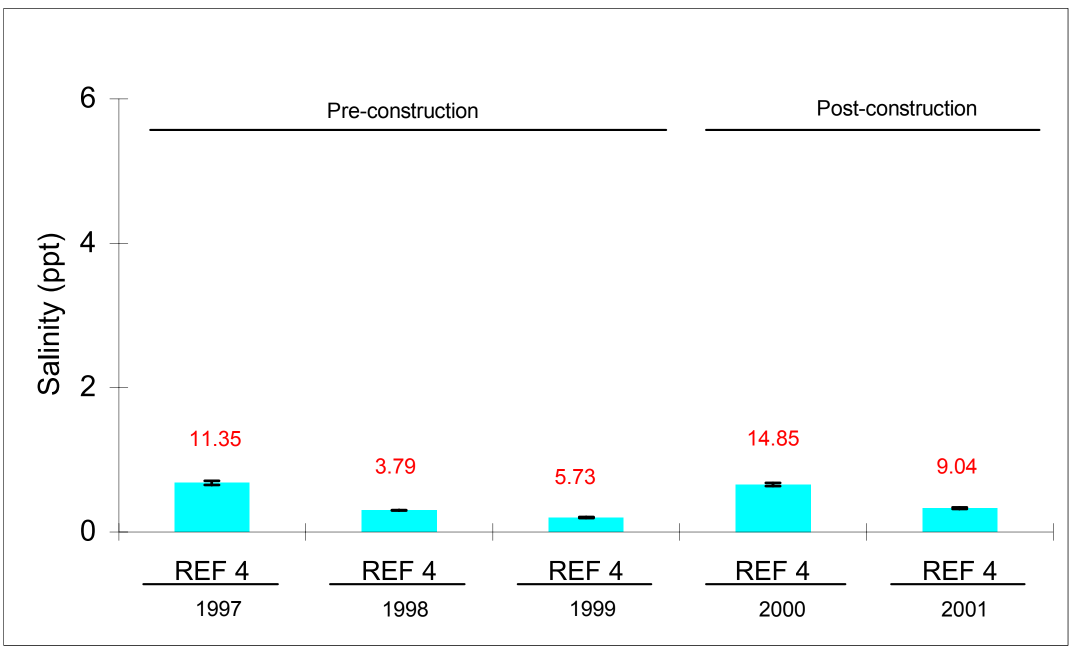

Figure 10. Mean and maximum salinity for REF 4.

With respect to reference area 4 (REF 4), which is located at the Fina camp, the mean salinity is below 1 ppt. However, high saline waters are capable of migrating up the canals during low water flow as indicated by the maximum salinity readings.

Does the project have the correct salinity for its marsh type?
According to the mean salinity readings, it is believed that the salinity concentrations are within the acceptable range for the marsh type. However, it must be noted that on occasion the salinity increases to levels that could be detrimental to the vegetation.

What were the salinity targets for the project and were they met?
According to the Monitoring Plan, Goal 4 of the project is to "decrease variability in salinities in the southern portion of the project" (Young 1998). As with the hydrology section in the plan, the salinities do not have specific enough goals to determine if the targets are being met. Also, without the operation of the structures and the incompleteness of construction, this question could not be answered according to the scope of the projects' design.

IV.2.4. Soils

What is the soil type that supports healthy marshes in the different marsh types?
In order to satisfy this specific inquiry, it is necessary to categorize the project area due to the unique features (hydrology, soils, and vegetation) that are specific for each area. The project can best be broken down by Conservation Treatment Units (CTU's) (refer to Project Plan Map on page 3). The determining border for these CTU's (3) are hydrologic barriers created by the existence of the Mauvis Bois Ridge and an oil and gas canal that runs primarily in a north/south direction.

In CTU-1, the soil type is predominantly Allemands Muck. This soil is a semi-fluid, organic soil and is located in marshes that are flooded most of the time. The soil profile consists of organic material within the first 2 feet (0.61 m), which gradually gives way to a semifluid, clayey material. There are approximately 2,200 acres (890 ha) of this soil type within the project which comprises 34.9% of the total area (USDA-NRCS 1996). Typically, the bulk density for soils of this marsh type is 0.11 grams per cubic centimeter (g/cc) in areas around streams and bayous and 0.09 g/cc for areas that occur in the interior (USDOI and USCOE 1984). This area supports a fresh marsh with *Sagittaria lancifolia* (bulltongue) as the dominant species and *Eleocharis sp.* (spikerush) contributing to the vegetative community. This marsh type makes up approximately 11% of marshes occurring in the Terrebonne Basin and has a relatively high diversity with a total of 52 species observed in this vegetative type (BTNEP 1996).

In CTU-2, soil types consist of roughly 2/3 Allemands Muck and 1/3 Carlin Peat (USDA-NRCS 1996). See previous paragraph for a description of Allemands Muck. The Carlin Peat is considered a "flotant" or floating marsh soil. Up to 4 feet (1.22 m) of organic matter is situated on the surface separated from the underlying, semi-fluid clayey horizon by a thin layer (2-3 in/5.1-7.6 cm) of water. Bulk density of these soils would be expected to be somewhat lower than CTU-1 given the fact that the Carlin Peats contain such a high level of organic matter and very little to no minerals for a deep surface depth. This marsh type is a fresh marsh being dominated by *Sagittaria latifolia* (duck potato) and *Sagittaria lancifolia*.

In CTU-3, soil types change to more brackish and intermediate and consist mostly of Clovelly Muck, Kenner Muck, Lafitte Muck, Larose Muck and Carlin Peat (USDA-NRCS 1996). Two soils, Clovelly Muck and Lafitte Muck also occur in the Very Slightly Saline to Slightly Saline phase. These soils have a deep organic upper layer ranging from almost 5 feet (1.52 m) thick for the Carlin Peat to 6 (15.2 cm) to 12 inches (30.5 cm) for the Larose Muck. For all of these series, semifluid, clayey material composes the bottom horizon.

Optimum bulk densities, for soils in this setting, range from 0.18 g/cc around shoreline areas to 0.08 g/cc for interior sites in intermediate marsh. Those areas that are considered brackish have bulk densities ranging from 0.27 g/cc around streambanks to a value of 0.08 g/cc for those areas occurring in the interior (USDOI and USCOE 1984). The majority of this CTU is classified as an intermediate marsh with the dominant species being *Spartina patens* with secondary occurrence of species of *Ludwigia leptocarpa* (false loosestrife) and *Sagittaria lancifolia* . A small percentage of CTU 3 is classified as an Oligohaline Wiregrass vegetation type. This area has experienced the most erosion with a large percentage of open water resulting. Evaluation Site (ES) information lists the range depth of this open water to be 1.5 feet (0.46 m)to over 3.5 feet (1.1 m) in some areas (SCS-Unpublished 1994).

For all soils in this project area, “Grain size” is not relevant unless you discuss those areas where the soils would have accreted some mineral content, mostly around streambanks and relic ridges. All other soils have organic matter as their top horizons where vegetative growth and soil respiration takes place (Tullos 2002).

CTU’s 1 and 2 have zero to very low levels of soil salinity. This is due to the fact that the Mauvis Bois Ridge provides a barrier (during normal weather periods) from the higher saline waters that may encroach from the south via Bayou Decade. These CTU’s also receive freshwater flushing when water levels from the Atchafalaya River are high via Bayou Penchant. Soil nutrient uptake by vegetation in these CTU’s is affected by anoxic and anaerobic conditions which “locks up” the available ions of soluble sodium, magnesium, calcium, potassium and sulfate. Nitrogen content is fairly constant across the marsh soils since it is closely associated with organic matter (USDOI and USCOE 1984). CTU 3 has had water salinity measured during the time period of 1992, 1993, and 1994. The data indicates that for the majority of time, average soil salinities did not exceed one (1) ppt. Salinity did increase up to two (2) ppt during July of 1992 and February of 1993. Also, high intensity storms, such as hurricane Andrew in August of 1992 raised salinity in CTU 3 to as high as 12 ppt. This rate decreased steadily after passage of the storm and at the end of the month was recorded at 8.0 ppt (BTNEP 1996). The absence (due to erosion) of the north shore of Bayou DeCade allowed this higher saline water to enter this CTU from the south. The relationship of soil nutrients are closely matched with those of the other CTU's (1 and 2). However, brackish areas tend to reduce sulfur (S) to insoluble sulfides which can accumulate in the soil and later be re-oxidized to sulfate (Tullos 2002).

Does the project have the correct soil for its marsh type?
It is perceived that this question is asking, "Does the current health and quality of the soil located in the project area support vegetation that traditionally, one would expect to find for this marsh type?". The health and quality of a soil will change due to various factors both natural and human-induced, but the soil type will always remain the same unless erosion is so severe that future surveys will classify the area as "open water".

The effect and support that specific soils within the project have on vegetation are affected by existing properties, past and future actions, and the variability of weather conditions. The conditions that exist in CTU's 1 and 2, still closely mimic those found when the soils were forming (freshwater flows), hence, it can be said that soils in these areas do support healthy marshes. However, ponding conditions, caused by impoundment of the area, have a net negative effect on vegetation. When elevated water levels exist on the surface for prolonged periods, resulting in an anaerobic condition, oxygen levels needed for proper plant respiration and production are affected.

In CTU 3, the existing soil type has seen its chemical and physical properties altered due to human and natural effects since their formation. The soils in these areas are subject to increased tidal energy, higher salinity levels, and increased energy with the loss of the north shoreline of Bayou Decade. Vegetative type and productivity respond in a parallel fashion to the forces which alter the chemical and physical properties of the soil. Soils in this area have responded to the factors that have occurred in the past (channelization, increased tidal influence, increased salinities). Vegetation that is present on these soils either adapts to the changing condition or dies and is replaced with an invasive plant species that can tolerate those conditions (i.e. increase salinity). If colonization does not occur before root systems can protect the organic surface by binding soil particles, much of the soil surface will be loss to erosion. The elevation of the soil will then be lowered sufficiently enough, and tidal influence will be increased, so that emergent vegetation can not become established and results in the permanent loss of surface material and conversion to open water.

IV.2.5. Shoreline Erosion

How have shoreline erosion rates changed in the project area compared to nearby reference areas?
The reduction of bankline erosion along natural and manmade channels was not a primary goal of the project. However, in an effort to enhance sediment retention and prevent expansion of tidal channels, rock armored earthen embankments and the construction of rock riprap embankments have eliminated erosion rates along such embankments.

IV.2.6. Other

When dealing with a project area that does have floating marshes, the entire area needs to be examined and characterized. It seems as though the northern portion of this project area may have more vertical variability than the southern area. The project should be constructed as planned and construction should be completed in its entirety. If there are financial constraints as the project progresses, there should be a system in place to handle these problems. If a project is not constructed completely, how can the area be monitored and conclusions be drawn. To this day, the project is still not completed in terms of monitoring for success or failure of the goals and objectives set forth by the Technical Advisory Group.

Other physical characteristics within the project area of note are:
1) Four existing water control structures;
2) Associated Oil and Gas production activities;
3) Recreational camp use;
4) Recreational fishing/hunting;
5) Several cultural and archeological sites.

IV.3. Suggestions for physical response monitoring

Are there other variables that could be monitored to substantially increase the ability to understand the results of the project?
Since a project objective is to "improve the retention of introduced freshwater and sediment", calculations or monitoring of the amount of freshwater and sediment entering and exiting the project should have been established. We do not know how much sediment enters the project area and exits the project area. Other agencies with external funding are examining the sediment load around the project; however, CWPPRA has no oversight on these studies.

V. BIOLOGICAL RESPONSE

V.1. Project Goals

The monitoring goals and objectives are the same as the project goals and objectives?
The DNR Monitoring Manager (Jennifer Young) wrote the monitoring goals and objectives from the project goals and objectives.

V.2. Comparison to adjacent and/or healthy marshes

V.2.1. Vegetation

What is the range in species composition and cover for healthy marshes in each type?
Vegetation was monitored in 1996 and 1999 (pre-construction) using the Braun-Blanquet sampling technique at 5 sites in each CTU and REF area. Each site has paired 1m x 1m plots. Figures 11 through 13 are relative mean cover percentages for each of the three CTU areas and the associated reference area.

Post-construction vegetation sampling will be conducted in the fall of 2002. This will be the first post-construction sampling effort for emergent vegetation.

Species composition in the project represents species that are commonly found in a fresh marsh: *Sagittaria lancifolia*, *Sagittaria latifolia*, (Dominant), *Ludwigia leptocarpa*, *Hydrocotly sp.* (pennywort), and *Eleocharis sp.* (Co-dominant). Within CTU's 1 and 2, there is also the occurrence of floating marsh both established and newly forming. CTU No. 3 consists of a majority of intermediate marsh with a small portion of brackish marsh. Dominant vegetative species include: *Spartina patens* (marshhay cordgrass), *Ludwigia leptocarpa*, *Sagittaria lancifolia*, and *Scirpus olneyi* (Olney bulrush). Eroded, open water areas are populated with submerged aquatic vegetative (SAV) species such as *Ceratophyllum demersum* (coontail), *Myriophyllum heterophyllum* (milfoil), and *Heteranthera dubia* (water stargrass) (USDA-NRCS 1996).

Does the project have the correct species composition and cover for its type?
Individual species were identified during pre-construction vegetation sampling by DNR and it appears that the project and reference areas have the appropriate species for freshwater and intermediate marshes. It is not evident whether plant cover is appropriate since a literature search on the subject was unsuccessful.

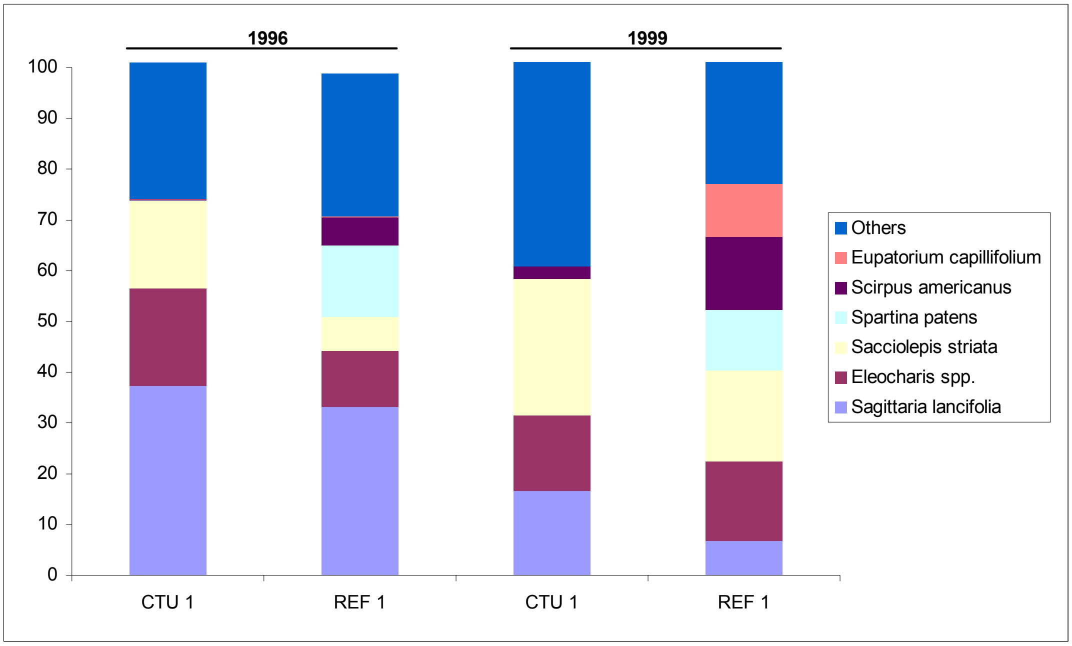

Figure 11. Relative mean cover percentages of dominant plant species in CTU 1 and REF 1.

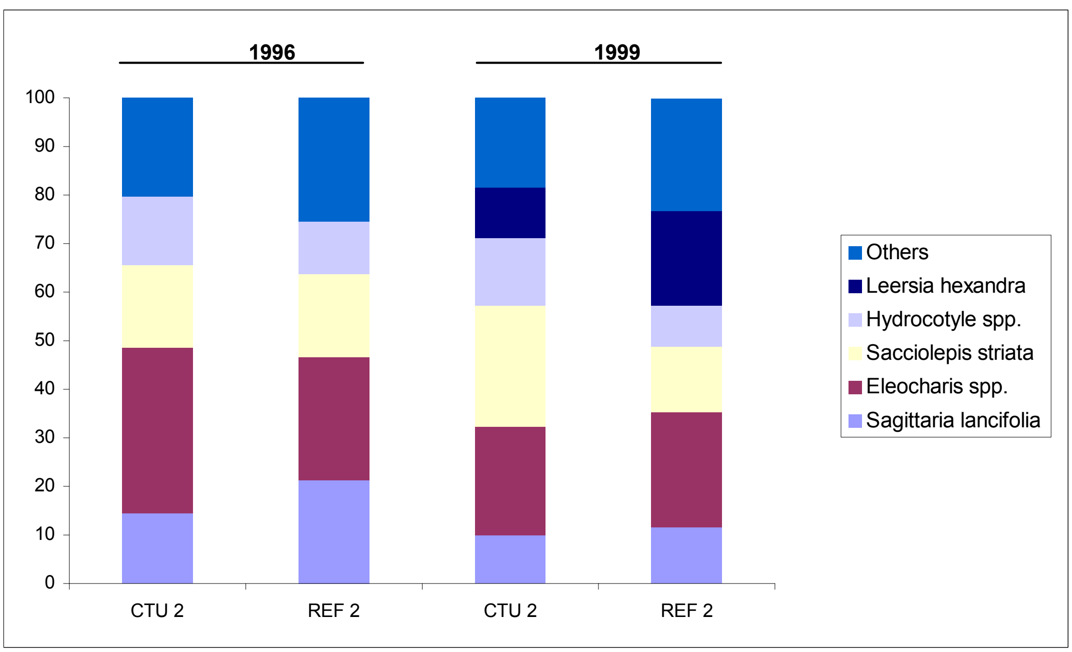

Figure 12. Relative mean cover percentages of dominant plant species in CTU 2 and REF 2.

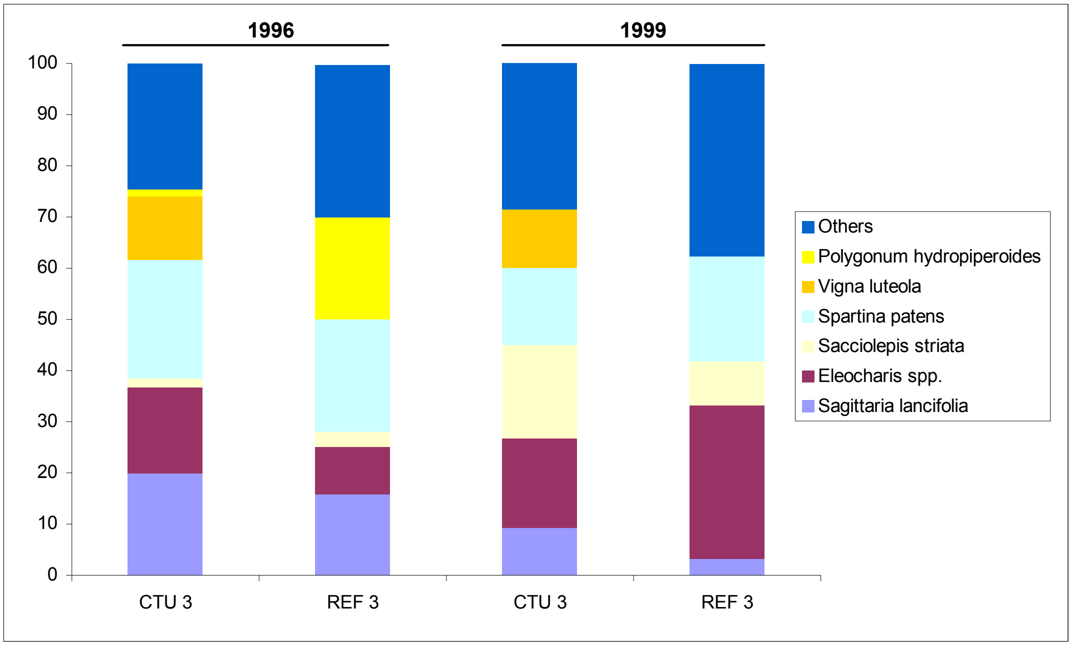

Figure 13. Relative mean cover percentages of dominant plant species in CTU 3 and REF 3.

The marshes within the project area reveal a vegetative species composition commonly found in areas that have experienced altered hydrologic regimes, increased tidal influence, and increased salinities. An example of this is the formation of new floating marsh as recorded on one of the ES sheet comments section "Early stage flotant" (SCS-Unpublished 1993). Also noted was "ponds are closing in as *Hydrocotly sp*, *Ludwigia leptocarpa*, *Bidens laevis* (bidens) and *Sacciolepis striata* (bagscale) become established on hyacinth rafts. Other comments reported were: "Flotant is older than at ES No. 2", "Flotant will not support a persons weight", "Transition area-fresh to intermediate marsh". For the brackish area (part of CTU 3), comments from the ES sheets read: "Very fragmented, broken marsh. Islands of vegetation and pedestalled marshhay cordgrass on edges".

What were the vegetation targets for this project and were they met? If not, what is the most likely reason?

According to the Monitoring Plan, Goal 2 was to "maintain or increase the abundance of plant species typical of a freshwater and intermediate marsh". If you were to examine the progression of the plant community by using the maps established by Chabreck and Linscomb, one would notice that the area was converting from a brackish marsh in 1949 to a fresh and intermediate marsh in 1988. This indicates that the area, during that time period, was reverting to a fresher plant community. It is the intention of the landowners and sponsors of the project to manage water levels and salinities such that areas north of the Mauvois Bois Ridge (CTU 1 & 2) are maintained as fresh marsh and south of the ridge (CTU 3) as intermediate marsh.

The number of plant species identified by DNR in 1999 was fewer than those identified in 1996 in CTU 1 and 3 and REF 1. The fewer number of plant species may be attributed to the knowledge of personnel sampling the vegetation and not a change in the plant community composition. Since a post-construction sampling has not occurred, a determination as to whether Monitoring Goal 2 is being achieved would be premature.

V.2.2. Landscape

What is the range in landscapes that supports healthy marshes in different marsh types?
N/A

Is the project changing in the direction of the optimal landscape? If not, what is the most likely reason?
Due to the postponed start of operating those project structural measures that have been targeted for water management scenarios, it is premature at this time to make a determination of landscape changes relative to project implementation.

V.2.3. Other

The other primary biological characteristic which may affect the project would be marsh eat-outs or other damage caused by overgrazing by nutria (*Myocaster coypus*). High populations of nutria can cause damage to marshes through herbivory, to the extent that marsh surfaces are denuded of vegetation and soil erosion may occur through tidal scour and result in the forming of open water areas. Nutria herbivory is playing a major role in the Barataria-Terrebonne basins. Direct vegetation removal contributes to permanent loss of vegetated wetlands. However, vegetative loss is not the only impact observed. "Nutria are currently and we suspect have historically, played a major role by influencing species composition throughout these basins. Only a small fraction of damaged sites have recovered since initial surveys in 1993" (BTNEP 1997).

V.3. Suggestions for biological response monitoring

Are there other variables that could be monitored to substantially increase the ability to understand the results of the project?
Another variable that should have been implemented was a biomass production element. This would have enabled the monitoring of marsh health from pre-construction to post-construction.

VI. ADAPTIVE MANAGEMENT

VI.1. Existing improvements

What has already been done to improve the project?
Since the project is only two years old, there have been no major improvements to the project at this point. However, progress has been made through the development of a structure operation schedule in August 2001, execution of the Operation and Maintenance Plan in July 2002, and the upcoming maintenance project scheduled for construction in October 2002 to repair breaches along Bayou Decade and other project deficiencies.

VI.2. Project effectiveness

Are we able to determine if the project has performed as planned? If not, why?
We are unable to determine at this time how the project has performed. The reasons for this determination lie in the facts that have been set forth during this outline. To briefly re-iterate the reasons, the project was not constructed entirely as designed, embankments were not constructed along Bayou Decade east of Jug Lake, the structure operation plan was not finalized before the end of construction, monitoring should be looking at how much sediment enters and exits the project to determine if the project is retaining sediment as outlined in the objective, biomass production plots should have been established to determine marsh health, and data collection instruments may not be located in areas that give the best answers to the goals and objectives.

What should be the success criteria for this project?
Post-operational data that has been analyzed is minimal and inconclusive to say definitively if the project has been successful. As mentioned previously, once construction ended structural operations were delayed, south Louisiana experienced a drought (2000) and a tropical storm (2001); consequently, salinity and water level measurements are inconclusive. Vegetation has only been sampled during pre-construction so no trends have been established.

VI.3. Recommended improvements

What can be done to improve the project?

1. All project components, as initially planned, should be completed.

2. The project needs to be operated as it was originally intended.
3. A more natural alternative than rock should be considered in the construction of remaining structures and in the maintenance of existing structures, if it can provide the same long-term protection at the same or better cost-effectiveness.

VI.4. Lessons learned

1. The structure operations plan needs to be completed before the end of construction.
2. If modifications to a project occur, the monitoring of the project may need to be altered. In the process that is currently in place, it does not allow for the monitoring plan to be altered very easily.
3. The goals and objectives of projects may need to be more specific. Targets which are ecologically significant may need to be placed on salinity values instead of identifying as "decrease variability." The same may apply with water levels within a project.
4. Monitoring plans should not include specific years, they should be referenced to years after construction because projects are not always completed on schedule at the time the monitoring plan is written.
5. More research is required during the planning stage of a project with respect to what has succeeded and failed on other similar type projects. Data should be studied more from other projects.
6. Structures should not be operated in a manner which is inconsistent with the goals of the project.
7. Structures should be designed so that the cost of adjusting the variable crested sections are minimal.
8. An Operation and Maintenance Plan should be developed prior to the 95% review phase and approved shortly after final inspection of all construction activities.
9. When two CWPPRA projects have overlapping project boundaries, significant project components of one project should never be deferred in anticipation that they could be installed in the second project.
10. There are plans to re-furbish the embankment along Bayou Decade and other breaches; however, it is DNR's understanding that rock will be used to do this. There needs to be research to support the use of rock as an effective water control structure that can control salinities and water levels.
11. A different method of bank refurbishment or bank stabilization should be investigated and pursued other than rock.

VII. SUPPORTING DOCUMENTATION

VII.1. Published References

Barataria-Terrebonne National Estuary Program (BTNEP). 1996. Marsh Vegetation – Types of Barataria and Terrebonne Estuaries: 1968-Present. BTNEP-29, August 1996. 17 pp. Plus Appendices.

Barataria-Terrebonne National Estuary Program (BTNEP). 1997. A Survey of Vegetative Damage Caused by Nutria Herbivory in the Barataria and Terrebonne Basins. BTNEP-31, April 1997. 17 pp. Plus Appendices.

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U. S. Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS). 2002. Project Completion Report. February 26, 2002. 8 pp.

U. S. Department of Interior (USDOI) and U. S. Department of the Army-Corps of Engineers (USCOE). 1984. The Ecology of Delta Marshes of Coastal Louisiana: A Community Profile. May 1984. 134 pp.

Young, J. 1998. Monitoring Plan: Project No. TE-28 Brady Canal Hydrologic Restoration. Louisiana Department of Natural Resources. 14 pp.

VII.2. Unpublished Sources

Agency	Year (Month)	Agency Contact	Document type	Short description	pages
NRCS	1994 (OCT)	Richard Abshire	Field Notes	Evaluation Site Field Sheets	16

VIII. PROJECT REVIEW TEAM

Name	Agency
Loland Broussard	NRCS
Richard Abshire	NRCS
Cindy Steyer	NRCS
Todd Folse	LDNR/CRD
Darin Lee	LDNR/CRD
Brian Babin	LDNR/CRD
Joy Merino	NMFS
John Foret	NMFS
Denise Reed	UNO
Richard Boe	USCOE

APPENDIX A: PROJECT INFORMATION SHEET

Project Name and Number: Brady Canal Hydrologic Restoration (TE-28)
Date: 08 MAR 2002

INFORMATION TYPE	YES	NO	N/A	SOURCE/COMMENTS
Fact Sheet	X			Richard Abshire, NRCS PPL-3 Report to Congress
Project Description	X			Richard Abshire, NRCS
Project Information Sheet	X			Richard Abshire, NRCS
Wetland Value Assessment	X			Marty Floyd, NRCS
Environmental Assessment	X			Richard Abshire, NRCS
Project Boundary	X			Richard Abshire, NRCS Candidate Fact Sheet Monitoring Plan
Planning Data	X			Richard Abshire, NRCS
Landrights	X			Helen Hoffpauir, LDNR/CRD
Preliminary Eng. Design	X			John Jurgensen, NRCS
Geotechnical	X			Cherie LaFleur, NRCS
Engineering Design	X			Cherie LaFleur, NRCS
As-Built Drawings	X			Brad Sticker, NRCS
Modeling Output			X	
Construct Completion Report	X			Brad Sticker, NRCS
Engineering Data	X			John Jurgensen, NRCS Castex Marsh Management Plan 404 & CUP Permit
Monitoring Plan	X			Todd Folse, LDNR/CRD
Monitoring Reports	X			Todd Folse, LDNR/CRD
Supporting Literature	X			USGS Data from Lee Foote Darin Lee, LDNR/CRD
Monitoring Data	X			Todd Folse, LDNR/CRD
Operations Plan	X			Garrett Broussard, LDNR/CRD
Operations Data	X			Garrett Broussard, LDNR/CRD
Maintenance Plan	X			Garrett Broussard, LDNR/CRD
Maintenance Data	X			Garrett Broussard, LDNR/CRD
O&M Reports	X			Garrett Broussard, LDNR/CRD
Permit	X			Richard Abshire, NRCS